Space Weather Technical Forecast

Issued on Monday, 07 March 2022 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-flares. Weak CME arrivals possible, with a chance of G1/Minor Storms mainly late day 4 (10th)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the period, with 1 C1 flare observed at 06/1257 from sunspot region 2957 Dso/Beta in the southwest. There are 6 sunspot regions on the disc including 2957, with the largest 2960 Ehi/Beta in the southwest, although this has remained stable with little growth observed. 2962 Cro/Beta in the northeast has also persisted amongst plage, but with no notable flare activity. 2961 Bxo/Beta in the southeast is showing signs of decay, whilst 2963 Bxi/Beta in the centre disc is a newly emerged region in the last 24 hours. There is also a small unnumbered Axx/alpha spot to the south of 2963, but this is now showing signs of decay. A filament eruption was observed in the area of ex-2958 in the northwest disc around 06/2245 UTC, with a subsequent CME observed on both LASCO and STEREO A coronagraph imagery. This has been assessed as having a potential Earth-directed component, with a glancing impact late on the 10th.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, was at elevated speeds through the period, ranging between 450-530 km/s, as recent fast wind enhancements only gradually eased. Density was initially at or just above average, but declined to mostly below. The total Interplanetary Magnetic Field strength (IMF), Bt was weak, at below 6nT. The north-south component (Bz) was mainly negative, with brief positive rotations, varying between +3nT and -4nT. Phi angle was mainly negative (towards the Sun). Geomagnetic Activity was Quiet to Unsettled (Kp1-3)

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2 MeV) was mainly High, with a peak value of 5010pfu at 07/1200UTC. The corresponding 24-hour integrated electron fluence rose above the Active (1e8 integrated pfu) threshold by 07/0000UTC, and remained above this level with an increasing trend. The 07/0000 UTC observation was 1.17e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Very Low, with further occasional C-class flares but with a chance of rising to Moderate from any M-class flares.

Solar Wind / Geomagnetic Activity: There are three potential CME arrivals in the forecast. The first has likely missed, as forecast, from the M2-flare on the 4th, but still has a chance for a weak arrival later on day 1 (7th). A further observed weak CME could move through late on the 9th or on the 10th (day 3 or day 4), although this is low confidence as no source could be identified and the observed CME is very weak. The filament eruption CME on the 5th is then expected to arrive late on the 10th (day 4), or perhaps just after this forecast period on day 5 (11th). Otherwise solar winds are expected to ease to background, with no coronal hole fast wind enhancements forecast. Geomagnetic activity is forecast to be mainly Quiet, with a chance of Unsettled intervals. Isolated Active spells are possible day 1 (7th) and late day 3 or day 4 (9th and 10th)

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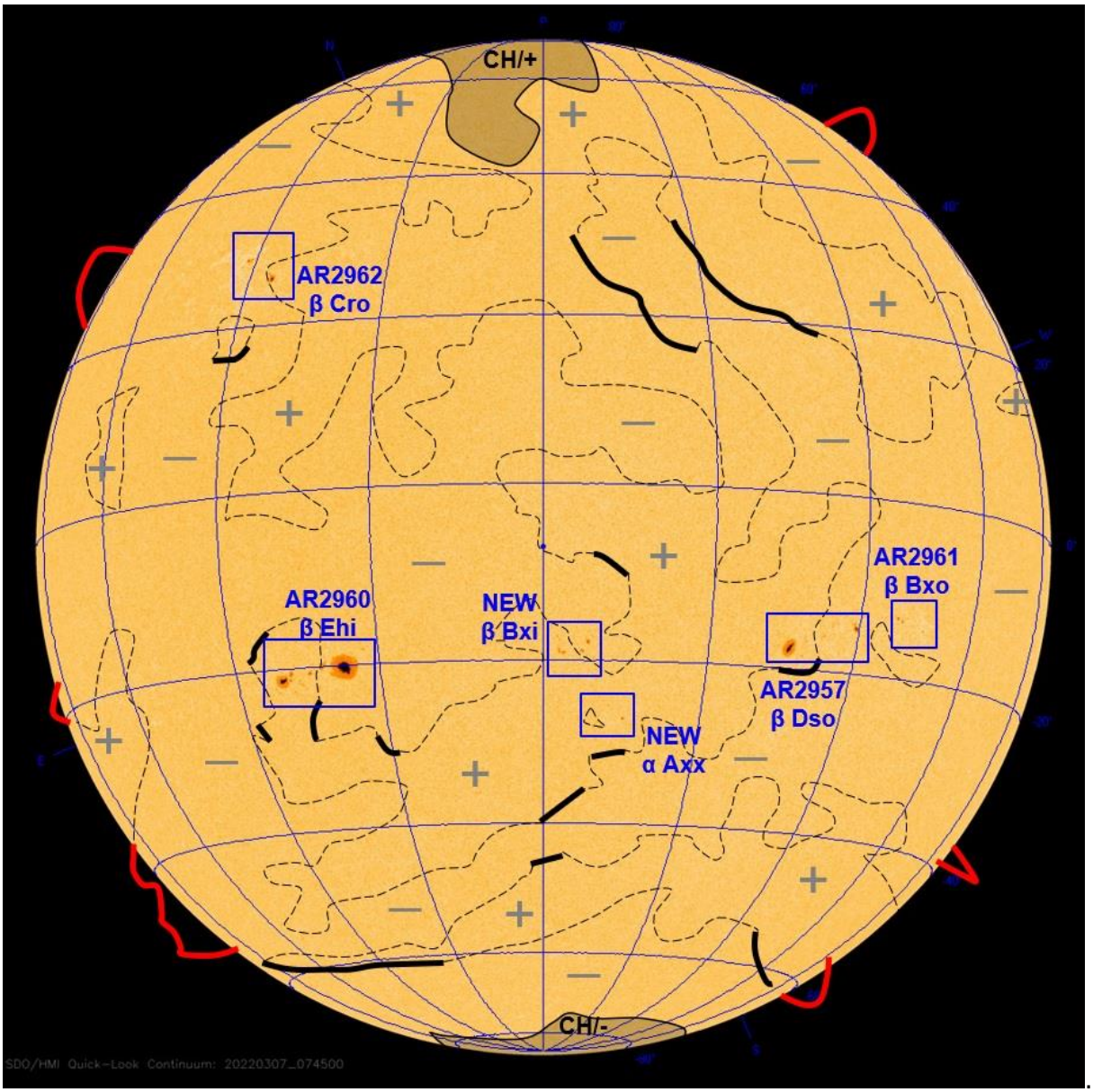
from any CME arrival. There is a slight chance of G1/Minor Storm intervals, mainly late day 4 (11th) from the glancing arrival of the third CME.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels. The high energy electron flux is expected to persist at High levels but with a chance of drop-out from any of the CME arrivals. This most likely to occur later day 4 (11th) with the arrival of the third CME (from the filament eruption 06/2245 UTC). The associated 24 hour fluence is expected to remain Active (above 18 integrated pfu) through the period, but with increased uncertainty towards the end of the period due to the potential arrivals.

Figure 1. Solar Analysis Valid 07/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The current fast wind regime is expected to gradually ease away through the period, with solar winds easing towards background and no further notable coronal hole source enhancements expected. However there are three potentially Earth-directed CMEs in the forecast.

The first was a glancing and weak CME produced by the M2 flare on the 2nd, although this was expected to be directed more to STEREO A and pass late on the 6th or early 7th. This has likely missed, but a late arrival cannot be ruled out early on the 7th (day 1). The second is very low confidence due to the lack of a clear source and also faint signal in imagery, however, a weak CME was observed early on the 5th, heading NE on SOHO LASCO and NW on STEREO A, suggesting the CME is directed between Earth and STEREO A. This would bring a weak CME arrival either very late day 3 (9th) or on day 4 (10th). Both of these are expected to be either weak, or missing Earth and unlikely to bring notable enhancements to geomagnetic conditions.

The third is a filament eruption from the vicinity of ex-2958 in the northwest quadrant around 26/2245. The subsequent CME is a partial halo on LASCO imagery, and gives a glancing arrival late on day 4 (10th).

Geomagnetic activity is forecast to be mainly Quiet through the period, with a chance of Unsettled intervals. Isolated Active spells are possible day 1 (7th) and late day 3 or day 4 (9th and 10th) from any CME arrival. There is a slight chance of G1/Minor Storm intervals, mainly late day 4 (11th) from the glancing arrival of the third CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/0601 UTC	Partial	AR2958	N05E39	270km/s	07/0300 UTC	Not arrived (Low confidence with range of arrival times)
06/0650 UTC	Partial	Unknown	N04E15	224km/s	10/1200UTC	Very low confidence with uncertain source
07/0920 UTC	Partial	Ex-2958	N10W24	417km/s	10/2100 UTC	Good confidence, but only glancing impact likely.

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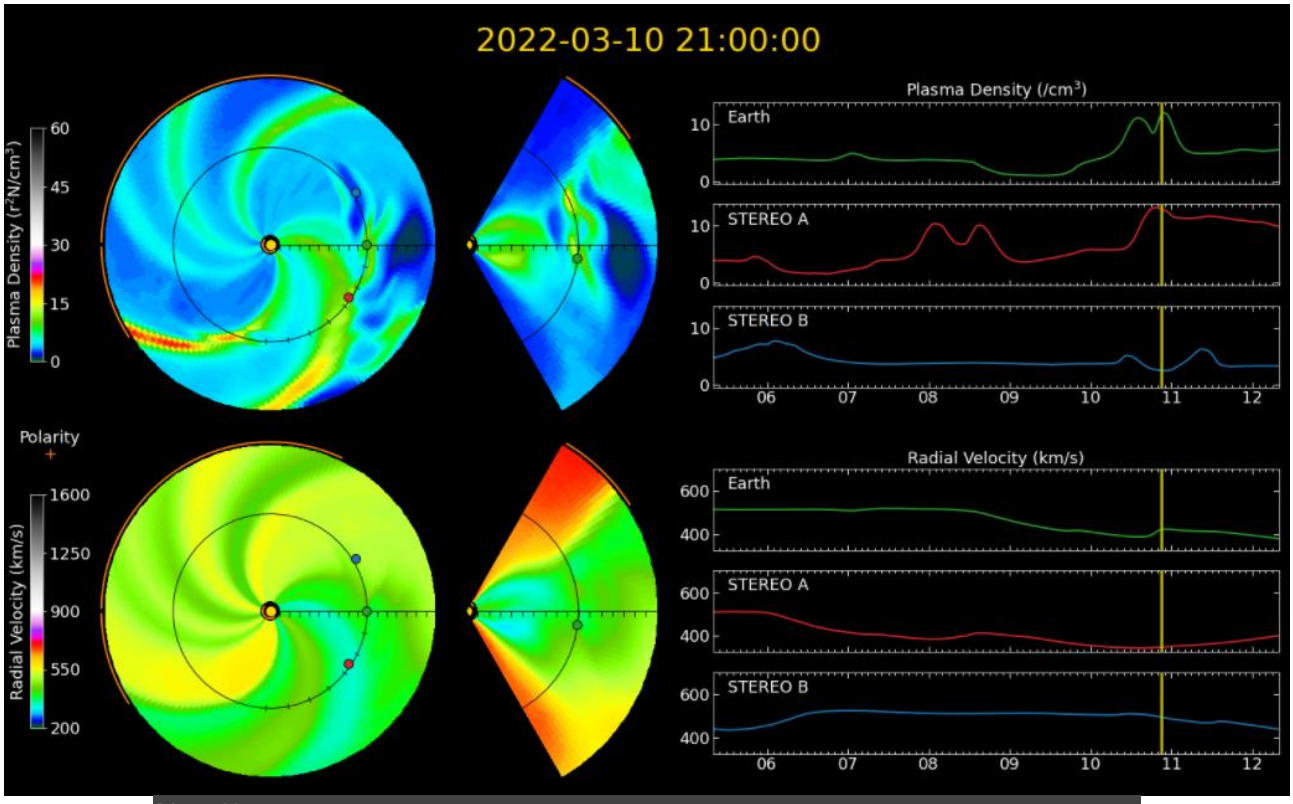
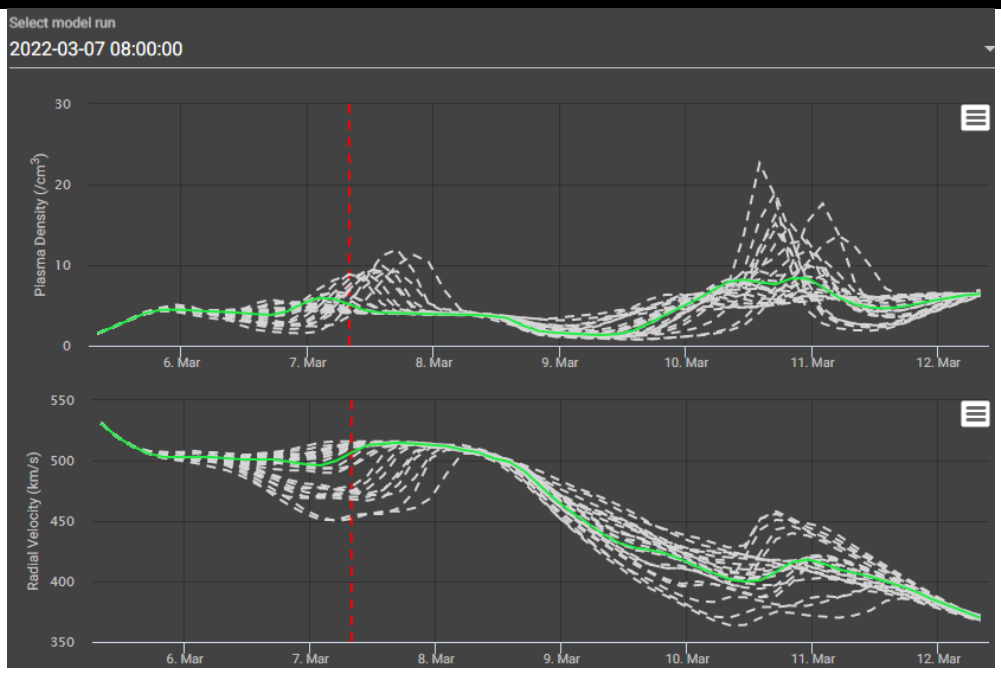
Figure 2: Enlil and Ensemble





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Radio Blackouts - X-Ray Flares:

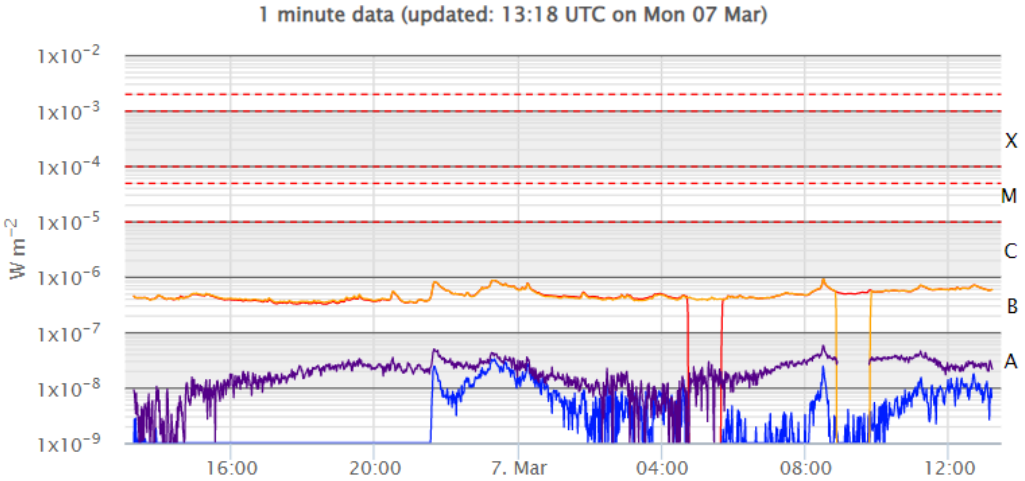
There are 6 sunspots regions on the visible disc, 5 of which have been numbered. The most prominent of these is the moderately large 2960 Ehi/Beta, however this has been relatively stable with only minor changes observed in its intermediate regions. 2957 Dso/Beta was the source of the sole C-class flare in the last 24 hours, however this also has seen only minimal development. The greatest development has been observed in newly numbered region 2963 Bxi/Beta in the centre disc, which has been the source of a B7-flare, however the growth in this region has currently stalled. 2962 Cro/Beta in the northeast has shown some evolution in shape, and is situated amongst a region of plage, leading to some potential for flaring despite its small size, but has remained relatively stable so far. Finally, 2961 is a small Bxo/Beta region to the west of 2957, and showing signs of decay. A small, unnumbered alpha spot is also present in the south centre disc.

A further bright flux region is visible on STEREO A euvi just over the northwest limb, with associated magnetic looping visible in SDO imagery. This could also be a source of potential flare activity as it rotates onto the disc during the next 12-36 hours.

Solar activity is currently Low, and is expected to remain Low to Very Low with any flares likely limited to C-class. There is a chance, however, for isolated M-flares (R1 Radio Blackout).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/17 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 is currently at Background and is expected to remain at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 is currently High, due to the recent fast wind enhancements. These flux levels are expected to persist for much of the period, but could see brief dropouts from any glancing CME arrivals either later day 1 (7th) or late day 3/day 4 (9th/10th), although these are low confidence. A more likely dropout is expected later on day 4 (10th) with a further CME arrival.

The associated 24 hour fluence is forecast to be Active (greater than 1e8 integrated pfu) for much of the period, but with an increasing chance of falling below from late day 2 onward. This is supported by REFM for the next 24 hours, however beyond this period this model currently gives poor guidance due to current conditions not comparing well to the 27-day persistence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	100	100	80	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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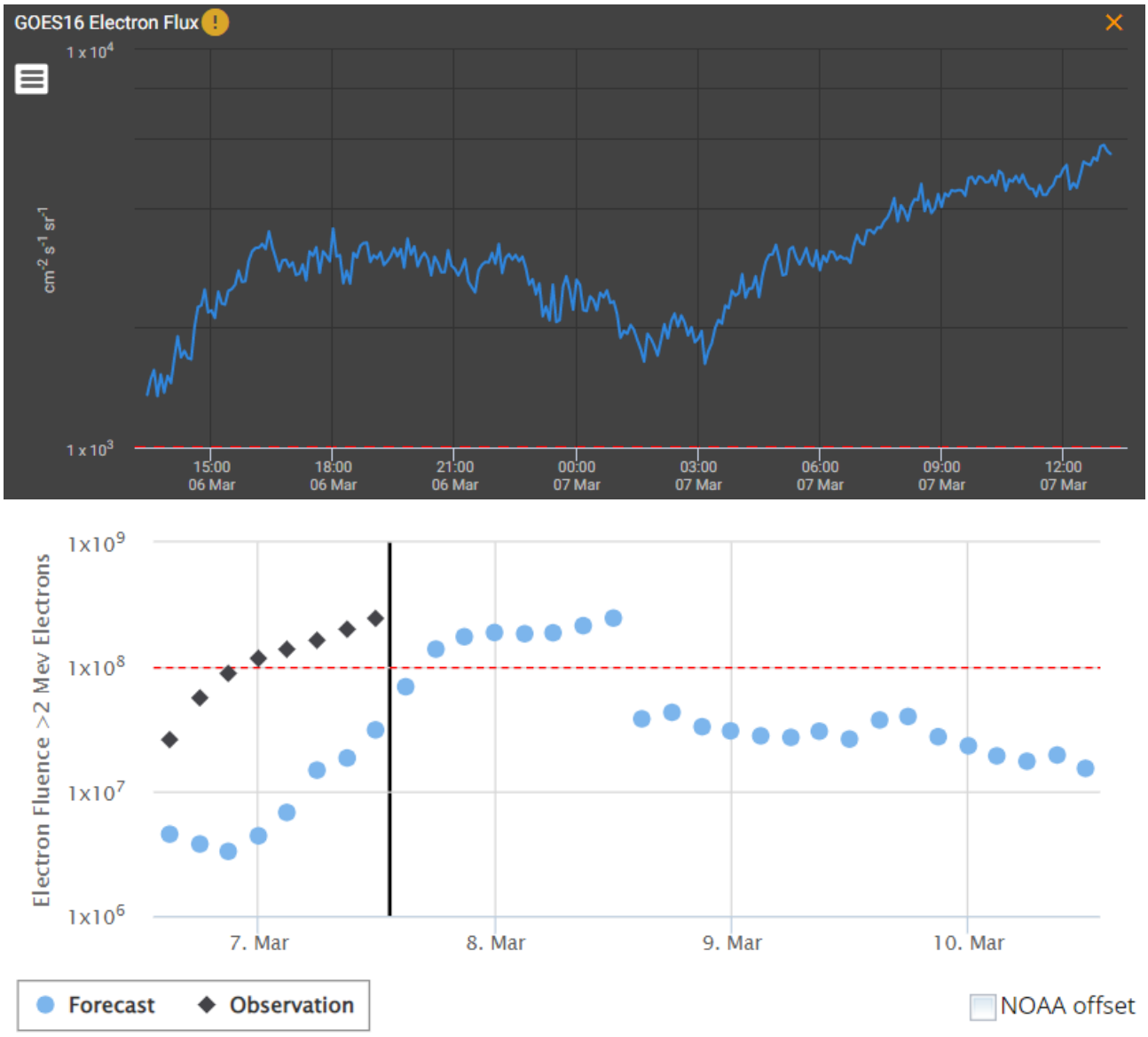
Figure 4: GOES-16 Electron Flux and Fluence with REFM



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